theſe, who may wiſh to adopt the propoſed improvements, to conſtruct Fire-places of all kinds on the principles recommended, without any farther aſſiſtance.

Thoſe who may not have leiſure to enter into theſe ſcientific inveſtigations, and who, notwithſtanding, may wiſh to imitate theſe inventions, will find all the information they can want in my next Eſſay.

An Account of the Kitchen of the HOUSE *of* INDUSTRY *at* MUNICH, *in its preſent State.*

THE large circular copper boiler (which is ſituated in a ſmall room adjoining to the great Kitchen) is fitted up in a very complete manner;—its (wooden) cover is cheap, ſimple, and durable, and anſwers perfectly well for confining the heat;—the ſteam tube (or ſteam chimney, as I have called it) is very uſeful, as it carries off all the ſteam generated in cooking, and keeps the air of the Kitchen dry and wholeſome.—To carry off the ſteam which riſes from the hot ſoup when it is ſerved up, there is a ſteam-chimney of wood, (furniſhed with a valve,) the opening of which is ſituated at the higheſt part of the Kitchen. To prevent the cold air from coming down by this paſſage into the Kitchen, its damper (which is opened and ſhut by a cord which goes over a pulley) is, in winter, kept conſtantly ſhut, except juſt when it is neceſſary to open it for a moment to let out the ſteam.

The only alteration I would make, were I to fit up this boiler again, would be to leave openings by which the flues might be cleaned occaſionally, without lifting the boiler out of its place.—This ſhould be done in the fire-places of all large boilers. This boiler, which is uſed every day, requires to have its flues cleaned, and its bottom and ſides ſcrubbed with a broom, to free them of ſoot, once in ſix weeks.

Over againſt this boiler is a machine for drying potatoes, which has been found to anſwer perfectly well the end for which it was contrived. Potatoes firſt moderately boiled, and then ſkinned and cut into thin ſlices, and dried in this machine, may be kept good for many years.

The eight iron boilers in the *great Kitchen* are fitted up on good principles; and the oven which is heated by the ſmoke from the fire-places of two of theſe boilers, which oven is deſtined for drying the wood for the uſe of this Kitchen, is deſerving of attention.

The wooden covers of theſe eight boilers, and the horizontal tubes, conſtructed of wood wound round with canvas and painted with oil colours, by which the ſteam is carried off, have been found to anſwer very well the purpoſes for which they were contrived.

The Kitchen of the Military Academy at MUNICH.

This Kitchen in its preſent ſtate is ſo perfect in all its parts, that I do not think it capable of any conſiderable improvement. The *roaſter*, which has been in daily uſe *ſeven years*, is ſtill in good condition, and bids fair to laſt *twenty years* longer.—It is large and roomy, and has been found to be extremely uſeful. Though the different parts of this Kitchen are not diſtributed with ſo much ſymmetry as could have been wiſhed, owing to local circumſtances, yet it is very complete in its various details, and all the various proceſſes of cookery are performed in it with little labour, and with a very ſmall expence indeed of Fuel. Two large boilers and three large ſaucepans, which are fitted up in a detached maſs of brick-work in a corner of the room, (on the right hand on going into it,) I can recommend as perfect models for imitation. In ſhort, I know of nothing which I could wiſh to alter in this Kitchen.—To ſay the truth, it has already undergone a ſufficient number of changes and alterations.

The Kitchen in the Military Hall or Officers' Meſs-Houſe in the Engliſh Garden at MUNICH.

This Kitchen is much leſs perfect in its details than that juſt mentioned.—It was built in the ſpring of the year 1790, and has ſince undergone only a few trifling alterations. It has three roaſters, which are made ſmall on purpoſe to ſerve as models for private families; and I have had the pleaſure to know that they have often been imitated.

The Kitchen in the Farm-Houſe in the Engliſh Garden.

This Kitchen is well-contrived for the uſe for which it was deſigned, and I can recommend it as a very good model for the Kitchens of Farm-houſes, for families conſiſting of eighteen or twenty perſons. One of the boilers, which is deſtined for warming water for the uſe of the Kitchen and the ſtables, is in winter heated by the ſmoke of a German ſtove which is ſituated in an adjoining room,—that inhabited by the Overſeer of the farm.

The great Kitchen of the Inn in the Garden.

This Kitchen, which is adjoining to the Farm-houſe, is contrived almoſt for the ſole purpoſe of roaſting chickens before an open fire, a kind of food of which the Bavarians are extravagantly fond. It has three open fire-places, conſtructed on the principles recommended in my Eſſay on Chimney Fire-places, fronting different ſides of the Kitchen, and all opening into the ſame chimney, which chimney is built nearly in the middle of the room. This Kitchen was built before my roaſters were come into uſe.

The ſmall Kitchen belonging to the Inn.

This Kitchen has nothing belonging to it which deſerves attention, or which I would recommend for imitation. It was originally deſigned merely for making coffee, chocolate, &c.

A Kitchen which has lately been fitted up on my principles, in the new Hoſpital for the infirm and helpleſs Poor, which is ſituated on the height called the *Gaſteig*, on the ſide of the river oppoſite to the town of Munich, is much more intereſting, and is a good model for imitation.

The Kitchen of the Hoſpital of La Piêta at VERONA

Is peculiarly intereſting, on account of its convenient form and the perfect ſymmetry of its parts.

The maſs of brick-work in which the boilers are fixed occupies the middle of one ſide of a large high room, which is plaſtered and white-waſhed, and neatly paved. The covers of the large boilers are lifted up by ropes which go over pullies fixed to the ceiling of the top of the room; but were I to build the Kitchen again, I ſhould ſubſtitute wooden covers with ſteam-chimnies inſtead of them, ſuch in all reſpects as that belonging to the large round copper boiler in the Kitchen of the Houſe of Induſtry at Munich. When the covers are ſo large that they cannot conveniently be lifted on and off with the hand, they ſhould, in my opinion, always be made of wood, and divided into parts, united by hinges. When they are deſigned for confining the ſteam *entirely*, they ſhould be made on a peculiar conſtruction, which will hereafter be deſcribed. The covers for ſmall boilers, and thoſe for ſaucepans, ſhould always be of tin, and double.

The grates on which the fires are made under the boilers in the Kitchen of the Hoſpital of *La Piéta*, are circular; but they are not hollow, or diſhing, as that improvement did not occur to me till after that Kitchen was finiſhed. The ſpiral flues under the boilers are alſo wanting, and for the ſame reaſon. In all other reſpects this Kitchen is, I believe, quite perfect.

The Kitchen of the Hoſpital of La Miſericordia *at* VERONA

Is conſtructed on the ſame principles as that of *La Piéta*. The only difference between them is in the diſtribution of the boilers. That of *La Miſericordia* is built round two ſides of the room. In many caſes, this manner of diſpoſing of the boilers will be found more convenient than any other; but in all caſes where this method of placing them is preferred, care muſt be taken to place the largeſt boilers fartheſt from the chimney, and the ſmaller ones nearer to it, and in regular ſucceſſion as their ſizes diminiſh. This is neceſſary, in order that in the maſs of brick-work in which the boilers are fixed, there may be room behind the ſmaller boilers for the canals which carry off the ſmoke from the large ones into the chimney.

This circumſtance was attended to in conſtructing the ſmall Kitchen which I fitted up laſt ſpring in the houſe of Sir John Sinclair, Bart. Preſident of the Board of Agriculture, Whitehall, London. This Kitchen (which was intended to ſerve as a model, and is open to the public view at all hours) is by no means as perfect as I wiſhed it to be:—Having been built during my journey to Ireland, ſeveral miſtakes were made by the workmen I employed, who, though they have great merit in their different lines of buſineſs, had not *then* had ſufficient experience in conſtructing Kitchens on my principles, to be able to execute ſuch a job in my abſence without committing ſome faults. Thoſe which were moſt eſſential I corrected; but my ſtay in England after my return from Ireland was too ſhort, and my time too much taken up with other matters, to rebuild the Kitchen from the foundation; which I was very deſirous of doing, and which, with the permiſſion of the Proprietor, I ſhall certainly do when I come to England again. The greateſt fault of the Kitchen is the want of dampers to the canals by which the ſmoke is carried off from the cloſed fire-places of the boilers and ſaucepans into the chimney. Theſe dampers ſhould never be omitted in any fire-place, however ſmall. They are neceſſary even in fire-places for the ſmalleſt ſaucepans, and no large boiler ſhould on any account be without one. Some Experiments I have lately made (ſince my return to Bavaria) have ſhewed me how very neceſſary theſe dampers are; and I conſider it as my duty to the Public to loſe no time in recommending the general uſe of them. The flattering attention which has been paid by the Public to the various improvements I have taken the liberty to propoſe, not only demands my warmeſt gratitude, but lays me under an indiſpenſable obligation to exert myſelf to the utmoſt to deſerve their eſteem, and to merit the diſtinguiſhed marks of their confidence with which on ſo many occaſions I have been honoured.

But to return to the Kitchen in the houſe of Sir John Sinclair (the place where the meetings of the Board of Agriculture are held, and where of courſe there is a great concourſe of ingenious men from all parts of the kingdom,—of men zealous for the progreſs of uſeful improvements). As the room is very ſmall, it was not poſſible to do more in it than juſt to fit up a few ſmall boilers and ſaucepans, and one middling-ſized roaſter, ſuch as might ſerve for a ſmall family; which laſt is a machine ſo very uſeful that I cannot help flattering myſelf that it will ſoon come into general uſe. The ſaving of Fuel which it occaſions is almoſt incredible, and the meat roaſted in it is remarkably well-taſted and high-flavoured.

One of theſe roaſters, on a large ſcale, was put up, under my direction, in the Kitchen of the Foundling Hoſpital in London; and though I could not ſtay in England to ſee it finiſhed, I have had the ſatisfaction to learn, ſince my arrival at Munich, from my friend Mr. Bernard, (who is Treaſurer to the Hoſpital,) that it has anſwered even beyond his expectations. He informs me, that when 112 lbs. of beef are roaſted in it at once, the expence for Fuel amounts to no more than *four pence* ſterling; and this when the coals are reckoned at an uncommonly high price, namely, at 1 s. 4 d. the buſhel.

In the roaſter belonging to the Kitchen of the Military Academy at Munich, I cauſed 100 lbs. Bavarian weight (equal to 123.84 lbs. Avoirdupois) of veal, in *ſix large pieces*, to be roaſted at once, as an Experiment; the Fuel conſumed was 33 lbs. Bavarian weight of dry pine-wood, (equal to 40.86 lbs. Avoirdupois,) which (at 4½ florins the *clafter*, weighing 2967 lbs. Bavarian weight) coſt 3 creutzers, or about *one penny* ſterling.

This Experiment was made in the year 1792. Happening to mention the reſult of it in a large company in London, ſoon after my arrival there in the autumn of the year 1795, I had the mortification to perceive very plainly by the countenances of my hearers how dangerous it is to promulgate very extraordinary truths. I afterwards grew more cautious, and ſhould not now have ventured to publiſh this account, had not the reſults of Experiments equally ſurpriſing, which have been made with the roaſter in the Kitchen of the Foundling Hoſpital, been made known to the Public.

Not only the roaſter, but the boilers alſo which have been put up under my direction in the Kitchen of the FOUNDLING HOSPITAL, have been found to anſwer very well; and I am informed that ſeveral other great Hoſpitals are about to imitate them. As I left London before the Kitchen of the Foundling Hoſpital was entirely finiſhed, I do not know whether there are dampers to the canals by which the ſmoke goes off from the fire-places of the boilers, and from that of the roaſter, to the chimney. If there are not, I could wiſh they might ſtill be added; and I would ſtrongly recommend it to thoſe who may be engaged in conſtructing Kitchen fire-places on my principles, never to omit them.

Oval grates of caſt iron, in the form of a diſh, ſuch as I have deſcribed in the foregoing Chapters of this Eſſay, were tried in the Kitchen of the Foundling Hoſpital; but the heat was found to be ſo intenſe that they were ſoon melted and deſtroyed; and we were obliged to have recourſe to common flat grates, compoſed of ſtrong bars of caſt iron. Perhaps the heat generated in the combuſtion of pit-coal is ſo intenſe, when completely confined, (as it ought always to be in cloſed fire-places,) that it will not be poſſible, where coals are uſed as Fuel, to uſe the hollow diſhing grates I have introduced in the public Kitchens at Munich, and which have been deſcribed and recommended in this Eſſay.

Since my return to Bavaria, I have made ſeveral Experiments with grates compoſed of common bricks, placed edgewiſe, and I find that they anſwer for that uſe full as well, if not better, than iron bars. By making bricks *on purpoſe* for this uſe, of proper forms and dimenſions, and compoſed of the beſt clay mixed with broken crucibles beaten to a coarſe powder, Kitchen fire-places might be fitted up with them, which would be both cheap and durable, and as perfect in all other reſpects as any that could poſſibly be made, even were the moſt coſtly materials to be uſed in their conſtruction.

To diminiſh ſtill farther the expence attending the conſtruction of cloſed Kitchen fire-places deſigned for the uſe of poor families, the opening by which Fuel is introduced might be cloſed with a brick, or with a flat ſtone;—another brick, or ſtone, might be made to ſerve at the ſame time as a regiſter and a door to the aſh-pit, and a third as a damper to the chimney or canal for carrying off the ſmoke from the fire-place.

I lately had an opportunity of fitting up a Kitchen on theſe principles, in the conſtruction of which there was not a particle of iron uſed, or of any other metal, except for the boiler. On the approach of the French army under General Moreau in Auguſt laſt, the Bavarian troops being aſſembled at Munich (under my command) for the defence of the capital, the town was ſo full of ſoldiers,

diers, that ſeveral regiments were obliged to be quartered in public buildings, and encamped on the ramparts, where they had no conveniencies for cooking. For the accommodation of a part of them, four large oblong ſquare boilers, compoſed of very thin ſheet coppers well tinned, were fitted up in a maſs of brick-work in the form of a croſs; each boiler with its ſeparate fire-place, communicating by double canals, furniſhed with dampers, with one common chimney, which ſtands in the centre of the croſs. The dampers are thin flat tiles; the grates on which the Fuel is burned are compoſed of common bricks, placed edgewiſe;—and the paſſages leading to the fire-place, and to the aſh-pit, are cloſed by bricks which are made to ſlide in grooves.

Under the bottom of each boiler, which is quite flat, there are three flues, in the direction of its length; that in the middle, which is as wide as both the others, being occupied by the burning Fuel. The opening by which the Fuel is introduced is at the end of the boiler *fartheſt from the chimney;* and the flame running along the middle flue to the end of it, divides there, and returning in the two ſide flues to the hither end of the boiler, there riſes up into two other flues, in which it paſſes along the outſide of the boiler into the chimney. The boilers are furniſhed with wooden covers divided into two equal parts, united by hinges. In order that the four boilers may be tranſported with greater facility from place to place, (from one camp to another for inſtance,) they are not all preciſely of the ſame ſize, but one is ſo much leſs than the other, that they may be packed one in the other. The largeſt of them, which contains the three others, is packed in a wooden cheſt, which is made juſt large enough to receive it. In the ſmalleſt may be packed a circular tent, ſufficiently large to cover them all. In the middle of the tent there muſt be a hole through which the chimney muſt paſs. The four boilers, together with the tent, and all the apparatus and utenſils neceſſary for a Kitchen on this conſtruction for a regiment conſiſting of 1000 men, might eaſily be tranſported from place to place on an Iriſh car drawn by a ſingle horſe.

I have been the more particular in my account of this portable Kitchen, as I think it would be found very uſeful for troops in camp. The Right Honourable Mr. Thomas Pelham made a trial of one of them laſt ſummer for his regiment, (the Suſſex militia,) and found it to be very uſeful. The ſaving of Fuel was very conſiderable indeed; and the ſaving of trouble in cooking not leſs important. The firſt Experiment we made together in a ſingle boiler, fitted up for the purpoſe in the open air, in the middle of the court-yard of Lord Pelham's houſe in London.

I ought perhaps to have reſerved what I have here ſaid on the ſubject of theſe Military portable Kitchens for my next Eſſay, where it would more naturally have found its place; but being perſuaded of the great advantages that may be derived from them, I am unwilling to loſe a moment in recommending them to the attention of thoſe who have it in their power to bring them into uſe.

Thoſe who wiſh to know more about them may, I am confident, procure every information they can deſire reſpecting them, by applying to Mr. Pelham, or to any of the Officers of the Suſſex militia who were in camp with the regiment laſt ſummer.

There is one more invention for the uſe of armies in the field, which I wiſh to recommend, and that is a *portable boiler* of a light and cheap conſtruction, in which victuals may be cooked *on a march*. There are ſo many occaſions when it would be very deſirable to be able to give ſoldiers, haraſſed and fatigued with ſevere ſervice, a warm meal, when it is impoſſible to ſtop to light fires and boil the pot, that I cannot help flattering myſelf that a contrivance, by which the pot *actually boiling* may be made to keep pace with the troops as they advance, will be an acceptable preſent to every humane officer and wiſe and prudent general. Many a battle has undoubtedly been loſt for the want of a good comfortable meal of warm victuals to recruit the ſtrength and raiſe the ſpirits of troops fainting with hunger and exceſſive fatigue.

But to return from this digreſſion.—The form of the two principal boilers in the Kitchen of the FOUNDLING HOSPITAL is that of an oblong ſquare; that form, which on ſeveral accounts I have reaſon to think preferable to all others for large boilers, but eſpecially on account of the facility of fitting them up with ſquare bricks, and of cleaning their flues, I firſt introduced in Ireland in ſeveral fire-places deſigned for different uſes, which I fitted up as models, in Dublin, during the viſit I made laſt ſpring to that country on the invitation of my friend Mr. Secretary Pelham.

The firſt of theſe oblong ſquare boilers is that which is fitted up in the court-yard of the Linen-hall at Dublin, *as a model for bleachers:* It is 8 feet wide, 10 feet long, and 2 feet deep; and it is furniſhed with a wooden cover, which ſhutting down in a groove in which there is a ſmall quantity of water, the ſteam is by theſe means confined in the boiler. This cover is moveable on its hinges, which are placed at the end of the boiler fartheſt from the door of the fire-place; and it is occaſionally lifted up by means of a rope, which goes over a compound pully which is fixed over the boiler at the top or ceiling of the room.

Under this Boiler there are five flues which run in the direction of its length, and are arranged and conſtructed in the ſame manner as the flues of the new Brewhouſe boiler which I lately fitted up at Munich.—(See Fig. 21, Plate V.)—There are no flues round the outſide of this boiler; but the brick walls by which they are defended from the cold air are double, and the ſpace between them is filled with charcoal duſt.

The Fuel burns at the hither end of the middle flue, in an oval diſh-grate; and the flame running along in this flue under the middle of the boiler to the farther end of it, there divides, and returns in the two adjoining flues :—It then turns to the right and left, and going back again in the two outſide flues to the farther end of the boiler, goes out from under it, there, in two canals, which ſloping upwards conduct it to the flues of a *ſecond boiler* of equal dimenſions with the firſt, where it circulates, and warms the water which is deſigned for refilling the firſt boiler.

As theſe boilers are made of exceedingly thin ſheet-copper, and *thin boilers* are ſtronger to reſiſt the effects of the Fire, and conſequently more durable, than very thick ones, they both together coſt much leſs than one ſingle boiler on the common conſtruction ; and Mr. Duffin, Secretary to the Linen-board, who is a very active, intelligent man, and is himſelf engaged in a large concern in the bleaching buſineſs, ſhowed me a computation founded on actual Experiments which he himſelf made with this new boiler, by which he proved that the ſaving of Fuel which will reſult from the general introduction of theſe boilers in the bleaching trade throughout Ireland will amount to at leaſt fifty thouſand pounds ſterling a-year.

In a LAUNDRY which I fitted up in the houſe belonging to the Dublin Society, (and which is deſigned to ſerve as a model for laundries for private gentlemen's families,) there are alſo two oblong ſquare boilers, the one heated by the Fire, and the other by the ſmoke ; and this ſmoke, after having circulated in the flues under the ſecond boiler, paſſes through a long flue, (conſtructed like hot-houſe flues,) which goes round two ſides of the *drying-room*, (which is adjoining to the *waſhing-room*,) and then paſſing through the wall of the drying-room into the ironing-room, it goes off into an open chimney. As the bottom of the ſecond boiler lies on a level with the top of the firſt, the warm water runs out of the ſecond to refill the firſt, by a tube furniſhed with a braſs cock, which greatly facilitates the filling of the principal boiler. The wooden covers of theſe boilers, which are double and moveable on hinges, are ſhut down in grooves in which there is water, and the ſteam being by theſe means confined, is forced to paſs off by a wooden tube ſtanding on a part of the cover which is faſtened down to the boiler with hooks, carries the ſteam upwards to the height of ſeven or eight feet, where it goes off laterally by another (horizontal) wooden tube, through the wall into the drying-room. As ſoon as this horizontal wooden tube has paſſed through the wall into the drying-room, it ends in a copper tube, about 3 inches in diameter, which, lying nearly in a horizontal poſition, conducts the ſteam through the middle of the drying-room in the direction of its length, and through a hole in a window at the end of the room into the open air.

The ſteam in paſſing through the drying-room in a metallic tube, (which is a good conductor of heat,) gives off its heat through the ſides of the tube to the air of the room, and the water which is condenſed runs off through the tube. By ſloping the tube *upwards*, inſtead of downwards, as by accident it was ſloped, the condenſed water, which is always nearly boiling hot, when it is condenſed, might be made to return into the boiler, which would be attended with a ſaving of heat, and conſequently of Fuel.

The furnace for heating the irons uſed in ſmoothing the linen, (or ironing, as it is called,) is a kind of oven built of bricks and mortar, the bottom of which is a ſhallow pan of caſt iron, 18 inches ſquare and about 3 inches deep, which is nearly filled with fine ſand. The Fire being made under this pan in a cloſed fire-place, as the ſand defends the upper ſurface of the pan from the cold air of the atmoſphere, the pan is commonly red-hot, and the irons, being ſhoved down through the ſand and placed in contact with this plate of red-hot metal, are heated in a very ſhort time, and at a ſmall expence of Fuel.

This contrivance might be uſed with great ſucceſs for covering the *hot plates* on which ſauce-pans are made to boil in many private Kitchens.

This ſtove, or oven, for heating the ſmoothing-irons, projects into the drying-room, but the door by which the irons are introduced, as well as that leading to the fire-place, and that leading to the aſh-pit, all open into the ironing-room.

The ſmoke goes off through the drying-room in an iron tube, and aſſiſts in warming the room and in drying the linen.

As it may ſometimes be neceſſary to heat the drying-room when neither the waſh-houſe boilers nor the ſtove for heating the ſmoothing-irons are heated, proviſion is made for that, by conſtructing a ſmall cloſed fire-place, deſigned merely for that purpoſe, which opens into the flue, by which the ſmoke from the boilers is carried round the drying-room. This fire-place (which is never uſed but when it is wanted for drying the linen) is ſituated juſt without the drying-room, under the end of the flue where it joins the ſecond boiler.— The opening at the top of its fire-place, by which the flame of the burning Fuel enters the under part of the flue, is kept cloſed by a ſliding plate of iron, or damper, when this fire-place is not uſed; and when it is uſed, the door which cloſes the opening into the fire-place of the firſt or principal boiler, and the regiſter in its aſh-pit door, are kept ſhut.

That the top of the principal boiler might not be too high above the pavement of the waſh-houſe for the laundreſſes to work in the boiler without being obliged to go up ſteps or ſtairs, the grate and the bottom of the flues under the boiler are nearly on a level with the pavement, and the aſh-pit is ſunk into the ground; and to render the approach to the opening into the fire-place more convenient in introducing the Fuel and lighting and managing the Fire, there is an area before the fire-place, about 3 feet ſquare and 2 feet deep, ſunk in the ground, and walled up on its ſides, into which there is a deſcent by ſteps. In two of the ſides of theſe vertical walls (thoſe on the right and left when you ſtand fronting the fire-place) there are vaults for containing Fuel, which extend ſeveral feet under the pavement. The ſteps which deſcend into this area are on the ſide of it, oppoſite the fire-place.

Areas of this kind are very neceſſary for all fire-places for large boilers, otherwiſe the top of the boiler will neceſſarily be raiſed too high above the level of the pavement to be approached with facility and convenience. Steps may be made, it is true, for approaching boilers which are placed higher; but theſe are always inconvenient, and take up more room, and coſt more than the execution of the plan here propoſed for rendering them unneceſſary.

The areas before the fire-place door of the large boilers in the Kitchen of the Foundling Hoſpital are occaſionally cloſed by trap-doors. As often as this is done there muſt be a number of ſmall holes bored in the door to permit the air neceſſary for feeding the Fire to deſcend into the aſh-pit; and when the bottom of the paſſage leading into the fire-place happens to lie above the level of the upper ſurface of this trap-door, the part of the door immediately under this opening ſhould, to prevent accidents from live coals which may occaſionally fall out of the fire-place, be covered with a thin plate of ſheet-iron.

When large boilers are fitted up in ſituations where it is not poſſible to ſink an area in front of the fire-place, the maſs of brick-work in which the boiler is ſet muſt be raiſed, and ſteps muſt be made to approach it. When this is done, the upper ſtep ſhould be made very wide, (at leaſt two feet,) in order that there may be room to ſtand and work in the boiler; and for ſtill greater convenience, the ſteps ſhould be continued round three ſides of the boiler, when the boiler ſtands in a detached maſs of brick-work. The bottom of the door of the fire-place ſhould, if poſſible, be above the upper flat ſurface of the upper ſtep; and to preſerve the ſymmetry of the whole, the aſh-pit door may be in the front of the upper ſtep, and the paſſage into the aſh-pit (which will be long of courſe) may deſcend in a gentle ſlope. In this manner the Kitchen of the Hoſpital of *la Pièta* at *Verona* was conſtructed.

No inconvenience whatever attends the increaſe of the length of the paſſage into the aſh-pit, except it be that very trifling one,—(which ſurely does not deſerve to be mentioned,)—the increaſe of labour attending the removal of the aſhes; but the inconvenience would be very conſiderable which would unavoidably attend the diſcontinuation, or breaking off, of the ſteps round the hither end, or front of the boiler, which would be neceſſary in order to be able to place the aſh-pit door *directly under* the fire-place door, and to make a way to approach it.

The flues under the principal boiler of the Laundry in the Houſe of the Dublin Society, are not contrived ſo as to divide the flame and cauſe it to circulate in *two* currents; they run from ſide to ſide under it: the door of the fire-place is not in the middle, but on one ſide of the boiler, and near one end of it. The flame paſſing and returning (under the boiler) twice from its front to its oppoſite ſide, goes off at its end (that fartheſt from the fire-place) into a canal furniſhed with a damper, which canal, riſing upward at an angle of about 45 degrees, leads to the flues under the ſecond boiler. The bottom of the flues of the principal boiler are juſt on a level with the pavement of the waſh-houſe; and, in order that they may eaſily be cleaned out, and the bottom of the boiler ſcrubbed with a broom to free it from ſoot, the ends of the flues are, in building the fire-place, left open, and afterwards, when the boiler is ſet, they are cloſed by temporary (double) walls of dry bricks. To make theſe walls tight, the joinings of the bricks are plaſtered on the outſide with moiſt clay.

The ſides of the boilers are defended from the cold air by thin walls of bricks covered with wainſcot, and by filling the ſpace between theſe walls and the boiler with pounded charcoal. Were I to fit up theſe boilers again, I ſhould leave this ſpace void, or filled merely with air, forming ſeveral ſmall openings below, through which the flame and hot vapour from the flues might aſcend and ſurround the boiler. In the large boiler fitted up in the Linen-hall as a model for bleachers, this alteration is alſo neceſſary to render it complete; and as it might be made in a few hours, and almoſt with-

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out any expence, I cannot help expreſſing a wiſh that it might ſtill be done.

The ardent zeal for the proſperity of his country, and indefatigable attention to every thing that tends to promote uſeful improvement, which ſo eminently diſtinguiſh that enlightened patriot and moſt reſpectable ſtateſman, to whom the manufactures and commerce of Ireland, and the linen-trade in particular, are ſo much indebted, encourage me to hope that he will take pleaſure in giving his aſſiſtance to render the models for improving fireplaces and ſaving Fuel, which I have had the ſatiſfaction of leaving in Ireland, as free from faults as they can poſſibly be made.

Though my ſtay in Ireland was too ſhort to conſtruct models of all the improvements I wiſhed to have introduced in that delightful and moſt intereſting iſland, yet the liberality with which my various propoſals were received, and the generous aſſiſtance I met with from all quarters, enabled me to do more in two months than I probably ſhould have been able to have effected in as many years in ſome other older countries, where the progreſs of wealth and of refinements have rendered it extremely difficult to get people to attend to uſeful improvements.

I wiſhed much to have been able to have fitted up the great Kitchen in the Houſe of Induſtry at Dublin, as the expence of Fuel is very conſiderable in that extenſive eſtabliſhment, where more than 1500 perſons are fed daily, at an average; but not having time to finiſh ſo conſiderable an undertaking, I thought it moſt prudent not to begin it. I fitted up one large boiler as a model at one end of one of the working-halls; but this was deſigned principally to ſhow how a large hall might be heated from a Kitchen fire-place, and from the very ſame Fire which is uſed for cooking *. The ſmoke from the fire-place is carried along horizontally on one ſide of the hall from one end of it to the other; and the boiler being cloſed by a cover which is ſteam-tight, the ſteam from the boiler is alſo forced along from one end of the hall to the other, in an horizontal leaden pipe, which runs parallel to the flue occupied by the ſmoke, and lies immediately over it. In warm weather, when the hall does not require to be heated, the ſmoke and ſteam go off immediately into the atmoſphere by a chimney adjoining to the fire-place, without paſſing through the hall.

To be able to equalize the heat in the hall,—(which is very long and narrow,)—or to render it as warm at the end of it which is fartheſt from the fire-place, as at that next the Fire, I directed clothing for the ſteam tube of warm blanketing to be made in lengths of three or four feet, to be occaſionally put round it and faſtened by buttons.

By clothing or covering the ſteam tube more or leſs, as may be found neceſſary in thoſe parts of the hall where the heat is greateſt, the ſteam being

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* This contrivance might eaſily be applied to the heating of hot-houſes, even though the hot-houſe ſhould happen to be ſituated at a conſiderable diſtance from the Kitchen.

by this covering prevented from giving off its heat to the air through the tube, will go on farther and warm thoſe parts of the hall which otherwiſe would be not ſufficiently heated. The ſteam tube, which is conſtructed of very thin ſheet-lead, is about 3 inches in diameter, and inſtead of being laid exactly in a horizontal poſition, ſlopes a little upwards, juſt ſo much that the water which reſults from the condenſation of the ſteam may return into the boiler *.

The horizontal flue through which the ſmoke paſſes is a round tube of ſheet-iron, about 7 inches in diameter, divided, for the facility of cleaning it, in lengths of 12 or 15 feet, fixed nearly horizontally at different heights from the floor, or, in an interrupted line, in hollow pilaſters or ſquare columns of brick-work. A common hot-houſe flue, conſtructed of bricks and mortar, would have an-

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* I contrived a fire-place for heating one of the principal churches in Dublin on theſe principles with ſteam (but without making uſe of the ſmoke); and I promiſed to give a plan (which, I am aſhamed to ſay, I have not yet been able to finiſh) for heating the ſuperb new building deſtined for the meeting of the Iriſh Houſe of Commons.

One of the two chimney fire-places, which I fitted up in the hall in which the meetings of the Royal Iriſh Academy are held, will, I imagine, be found to anſwer very well for heating high rooms and large halls in private houſes. In this fire-place I have endeavoured, and I believe ſucceſsfully, to unite the advantages of an open fire with thoſe of a German ſtove. The grate uſed in fitting up this fire-place, and which is of caſt iron, and far from being unelegant in its form, and which coſt only *ſeven ſhillings and ſixpence ſterling*, is decidedly the beſt adapted for open chimney fire-places, where coals are uſed as Fuel, of any I have yet ſeen. By a letter I lately received from a friend in Ireland, I had the ſatisfaction to learn that theſe grates are coming very faſt into general uſe in that country.

ſwered equally well for warming the hall, but would have taken up too much room, which is the only reaſon it was not preferred to theſe iron tubes.

In conſtructing the boiler, (which is of thin ſheet-iron,) I made an Experiment which ſucceeded even beyond my expectation. The flues under the boiler—(and there are none round it)—are projections from the bottom of the boiler;—they are hollow walls of ſheet-iron, about 9 inches high, and an inch and three quarters thick, into which the liquid in the boiler deſcends, and which in fact conſtitute a part of the boiler. By this contrivance the flame is ſurrounded on all ſides, except at the bottom of the flues, (where the heat has little or no tendency to paſs,) by the liquid which is heated, and the fire-place is merely a flat maſs of brick-work. The grate is even with the upper ſurface of this maſs of brick-work, and the aſh-pit is the only cavity in it.

In conſtructing the boiler, proviſion was made, by omitting or interrupting the hollow walls or diviſions of the flues, in the proper places, to leave room for introducing the Fuel,—for the paſſage of the flame from one flue to another,—and from the laſt flue into the canal by which the ſmoke goes off into the chimney, or into the iron tubes by which the hall is occaſionally warmed.

One principal object which I had in view in this Experiment was to ſee if I could not contrive a boiler, which, being ſuſpended under a waggon or other wheel carriage, might ſerve for cooking for troops on a march; or which, being merely ſet down on the ground, a fire might be immediately kindled under it.

Thoſe who will take the trouble to examine the boiler in queſtion, will find that the principle on which it is conſtructed may eaſily be applied to the objects here mentioned. But it is not merely for portable boilers that this conſtruction would be found uſeful; I am convinced that it would be very advantageous for the boilers of ſteam-engines,—for diſtilleries,—and for various other purpoſes. As the eſcape of heat into the brick-work is almoſt entirely prevented, and as the ſurface of the boiler on which the heat is made to act is greatly increaſed by means of the hollow walls, the liquid in the boiler is heated in a very ſhort time, and with a ſmall quantity of Fuel.

There is ſtill another advantage attending this conſtruction, which renders it highly deſerving the attention of diſtillers. By making the tops of the flues arched inſtead of flat, (which may eaſily be done, and which is actually done in the boiler in queſtion,) or in the form of the roof of a houſe, as the hotteſt part of the flame will of courſe always occupy the upper part of the flues, and as the thick or viſcous part of the liquor in the boiler, that which is in moſt danger of being burned to the bottom of the boiler, and giving a bad taſte to the ſpirit which comes over, cannot well lie on the convex or ſloping ſurface of theſe flues, there will be leſs danger of an accident which diſtillers have hitherto found it extremely difficult to prevent.

In conſtructing boilers on theſe principles for diſtillers, it will probably be found neceſſary to increaſe very much the thickneſs of the hollow walls of the flues; and perhaps to make them even deeper than the level of the bottom of the flues, in order more effectually to prevent the thick matter which will naturally ſettle in thoſe cavities from being expoſed to too great a heat.

A ſimilar advantage will attend large boilers conſtructed on theſe principles for making thick ſoups for hoſpitals; theſe ſoups being very apt to burn to the bottoms of the boilers in which they are prepared.

I made another Experiment in the Houſe of Induſtry in Dublin, which I wiſhed much to have had time to have proſecuted farther. Finding that the expence for wheaten bread for the Houſe was very great, (amounting, in the year 1795, to no leſs than 3841 l. ſterling,) I ſaw that a very conſiderable ſaving might be made by furniſhing thoſe who were fed at the public expence with oaten cakes, (a kind of bread to which they had always been uſed,) inſtead of rendering them dainty and ſpoiling them by giving them the beſt wheaten bread that could be procured, as I found had hitherto been done. But to be able to furniſh oaten cakes in ſufficient quantities to feed 1500 perſons, ſome more convenient method of baking them than that commonly practiſed was neceſſary, and one in which the expence of Fuel might be greatly leſſened.

With a view to facilitate this important change in the mode of feeding the numerous objects of charity, and of *correction*, who were ſhut up together within the walls of that extenſive eſtabliſhment, I conſtructed what I would call a *Perpetual Oven.*

In the centre of a circular, or rather cylindrical maſs of brick-work, about eight feet in diameter, which occupies the middle of a large room on the ground floor, I conſtructed a ſmall circular cloſed fire-place for burning either wood, peat, turf, or coals. The diameter of the fire-place is about eleven inches, the grate being placed about ten inches above the floor, and the top of the fire-place is contracted to about four inches. Immediately above this narrow throat, ſix ſeparate canals (each furniſhed with a damper, by means of which its opening can be contracted more or leſs, or entirely cloſed) go off horizontally, by which the flame is conducted into ſix ſeparate ſets of flues, under ſix large plates of caſt iron, which form the bottoms of ſix ovens on the ſame level, and joining each other by their ſides, which are concealed in the cylindrical maſs of the brick-work. Each of theſe plates of caſt iron being in the form of an equilateral triangle, they all unite in the centre of the cylindrical maſs of brick-work, conſequently the two ſides of each unite in a point at the bottom of it, forming an angle of ſixty degrees.

The flame, after circulating under the bottoms of theſe Ovens, riſes up in two canals concealed in the front wall of each Oven, and ſituated on the right and left of its mouth, and after circulating again in ſimilar flues on the upper flat ſurface of another triangular plate of caſt iron which forms the top of the Oven, goes off upwards by a canal furniſhed with a damper into a hollow place, ſituated on the top of the cylindrical maſs of the brick-work, from which it paſſes off in a horizontal iron tube, about ſeven inches in diameter, ſuſpended near the ceiling of the room, into a chimney ſituated on one ſide of the room.

Theſe ſix Ovens, which are contiguous to each other in this maſs of brick-work, are united by their ſides by thin walls made of tiles about 1½ inches thick, and 10 inches ſquare, placed edgewiſe, and each Oven having its ſeparate canal, furniſhed with a regiſter communicating with the fire-place, any one or more of them may be heated without heating the others, or the heat may be turned off from one of them to the other in continual ſucceſſion; and, by managing matters properly, the proceſs of baking may be *uninterrupted.* As ſoon as the bread is drawn out of one of the Ovens, the Fire may immediately be turned under it to heat it again, while that from under which the Fire is taken is filled with unbaked loaves, and cloſed up.

A principal object which I had in view in conſtructing this Oven was to prevent the great loſs of heat which is occaſioned in large Ovens, by keeping the mouth of the Oven open for ſo conſiderable a length of time as is neceſſary for putting in and drawing out the bread. As one of theſe ſmall Ovens contains only five large loaves, or cakes, it may be charged, or the bread when baked may be drawn, in a moment; and, during this time, the other five Ovens are kept cloſed, and conſequently are not loſing heat; *one* of them is heating, while the other *four* are filled with bread in different ſtages of the proceſs of baking.

When I conſtructed this Oven, though I had no doubt of its being perfectly well calculated for the uſe for which it was principally deſigned,—baking oaten cakes, which are commonly baked on heated iron plates,—yet I was by no means ſure it would anſwer for baking common bread in large thick loaves. I had not made the Experiment. And though I could not conceive that any thing more could be neceſſary in the proceſs of baking than *heat*,—and here I was abſolutely maſter of every degree of it that could poſſibly be wanted, and could even regulate the ſucceſſion of different degrees of it at pleaſure,—I thought it probable that ſome particular management might be required in baking bread in theſe metallic ovens, a knowledge of which could only be acquired by experience.

What ſerved to ſtrengthen theſe ſuſpicions was a diſcovery which had accidentally been made by the cook of the Military Academy. In the courſe of *his* experiments, he found that my Roaſter is admirably well calculated for baking pies, puddings, and paſtry of all kinds;—provided however that the Fire be managed *in a certain way;*—for when the Fire is managed in the ſame manner in which it ought to be managed in roaſting meat, pies and paſtry will abſolutely be ſpoiled. After repeated failures and diſappointments, and after having loſt all hopes of ever being able to ſucceed in his attempts, the cook (by mere accident, as he aſſured me) diſcovered the important ſecret;—and important he certainly conſiders it to be, and feels no ſmall degree of ſatisfaction,—not to ſay pride,—in having been ſo fortunate as to make the diſcovery. He muſt pardon me if I take the liberty,—even without his permiſſion,—to publiſh it to the world for the good of mankind.

The Roaſter muſt be well heated before the pies or paſtry are put into it, and the blowers muſt never be quite cloſed, during the proceſs.

I have lately found that by uſing ſimilar precautions, bread may be perfectly well baked in metallic Ovens, ſimilar to that in the Houſe of Induſtry in Dublin.

Thinking it more than probable that means might be deviſed for managing the heat in ſuch a manner as to perform that proceſs in Ovens conſtructed on theſe principles, and heated *from without;* and conceiving that not only a great ſaving of Fuel, but alſo ſeveral other very important advantages, could not fail to be derived from that diſcovery, on my return to Munich from England, in Auguſt laſt, I immediately ſet about making Experiments, with a view to the inveſtigation of that ſubject; and I have ſo far ſucceeded in them that, for theſe laſt four months, my table has been ſupplied entirely with bread baked in my own houſe, by my cook, in an Oven conſtructed of thin ſheet-iron, which is heated (like my Roaſters) from without;—and I will venture to add, that I never taſted better bread. All thoſe who have eaten of it have unanimouſly expreſſed the ſame opinion of it. It is very light,—moſt thoroughly baked without being too much dried,—and I think remarkably well-taſted. The loaves, which are made ſmall in order that they may have a greater proportion of cruſt, (which, when the bread is baked in this way, is ſingularly delicate,) are placed in the Oven on circular plates of thin ſheet-iron, raiſed about an inch on ſlender iron feet. Were the loaf placed on the bottom of the Oven, the under cruſt would preſently be burnt to a coal, and the bread ſpoiled. A precaution abſolutely neceſſary in baking bread in the manner here recommended, is to leave a paſſage for the ſteam generated in the proceſs of baking to eſcape. This may be done either by conſtructing a ſteam-chimney for that purpoſe, furniſhed with a damper; or ſimply by making a regiſter in the door of the Oven.

As this is not the proper place to enlarge on this ſubject, I ſhall leave it for the preſent; but I cannot help expreſſing a wiſh, that what I have here advanced may induce others, eſpecially *Bakers*, who may find their own advantage in the proſecution of theſe intereſting and important inveſtigations, to turn their attention to them.

How exceedingly uſeful would my Roaſters be, and Ovens conſtructed on the principles here recommended, on ſhipboard!—Having ſerved a campaign (as a volunteer) in a large fleet, (that commanded by Admiral Sir Charles Hardy in the year 1779,) and having made ſeveral long ſea-voyages, I have had frequent opportunities of ſeeing how difficult it is in bad weather to cook at ſea; and it is eaſy to imagine how much it would contribute to the comfort of ſeafaring people, eſpecially at times when they are expoſed to the greateſt fatigues and hardſhips, to enable them to have their tables well ſupplied with warm victuals.

In order that the motion of the veſſel might not derange any part of the apparatus uſed in the proceſs of cooking at ſea in my Roaſters, the form of the Roaſter ſhould be that of a perfect cylinder, and the dripping-pan in which the meat is placed ſhould be a longitudinal ſection of another cylinder, leſs in diameter than the Roaſter by about an inch, and ſuſpended on two pivots in the axis of the Roaſter, in ſuch a manner that the dripping-pan may ſwing freely in the Roaſter, without touching its ſides. The Roaſter ſhould be placed in the brick-work, with its axis in the direction of the length of the ſhip; and to prevent the gravy from being thrown out of the dripping-pan when the veſſel pitches, its hollow cavity ſhould be divided into a number of compartments, by partitions running acroſs it from ſide to ſide.

It remains for me to give ſome account of the Kitchen which I fitted up in the Houſe of the Dublin Society, as a model for private families;—and alſo of a Cottage Fire-place, and a Lime-kiln, which I conſtructed, as models for imitation, in the court-yard of that public building.

With regard to the Kitchen, it is neceſſary that I ſhould remark at ſetting out, that it was not intended ſo much to ſerve as a model complete of a convenient Kitchen for a private family, as to diſplay a variety of uſeful inventions, all or any of which may at pleaſure be eaſily adopted, in Kitchens of all kinds and of all dimenſions. I thought this would be more uſeful than any ſimple model of a Kitchen I could contrive.

It is however a very complete Kitchen; and though there are ſome contrivances belonging to it which might have been omitted, yet they will all, I am confident, be found uſeful for the different purpoſes for which they were particularly deſigned; and, in a Kitchen for a large family, would often come into uſe.

The general diſpoſition of the various parts of this Kitchen I conſider as being quite perfect. It is the ſame as that of the Hoſpital of *la Pièta* at *Verona*; and of a very complete private Kitchen which was built about two years ago at Munich, under my direction, in the houſe of BARON LERCHENFELD, Steward of the Houſehold to HIS

MOST SERENE HIGHNESS THE ELECTOR. In my next Eſſay, which will treat excluſively of the Conſtruction of Kitchen Fire-places, and of Kitchen Utenſils, I ſhall give a particular detailed account of the manner in which the various Boilers,—Steam-boilers,—Saucepans,—Oven,—Roaſters, &c.—are diſpoſed and connected in the maſs of brick-work in theſe Kitchens; and ſhall accompany theſe deſcriptions with a ſufficient number of Plates to render them perfectly intelligible.

Cottage Fire-place, and Iron Pot, for cooking for the Poor.

THE Cottage Fire-place which I fitted up as a model, in the court-yard of the Houſe of the Dublin Society, was not quite finiſhed when I left Ireland; but an idea may be formed from what was done of the general principles on which ſuch Fire-places may be conſtructed. On each ſide of the open chimney Fire-place, (which, being ſmall, was built in the middle of one much larger, which was conſtructed to repreſent a large open Fire-place, ſuch as are now general in Cottages,) I fitted up an Iron Pot on a peculiar conſtruction, caſt by Mr. Jackſon of Dublin, and deſigned for the uſe of a poor family in cooking their victuals. This Pot is nearly of a cylindrical form, about ſixteen inches in diameter, and eight inches deep; and under its bottom, which is quite flat, there is a thin ſpiral projection, which was caſt with the Pot, and ſerves inſtead of feet to it, the turns of which, when the Pot is ſet down on a flat ſurface, form a ſpiral flue in which the flame circulates under the bottom of the Pot. This projection, which is near half an inch thick where it is united with the bottom of the Pot, and leſs than a quarter of an inch below where its lower edge reſts on the ground, is about four inches wide, or rather deep. This projection was made tapering, in order to its being more eaſily caſt. To defend the outſide of this Pot from the cold air, the Pot is incloſed in a cylinder of thin ſheet-iron, equal in diameter to the extreme width of the Pot at its brim,—juſt as high as the depth of the Pot and of its ſpiral flues taken together. The Pot is faſtened to this cylindrical caſe by being driven into it with force, a rim in the form of a flat hoop, about an inch and an half deep and a little tapering, being caſt on the outſide of the Pot at its brim, the external ſurface of which was fitted exactly into the top of this cylinder. This projection is uſeful, not only in uniting the Pot to its cylindrical caſe, but alſo to keep this cylindrical caſe at ſome ſmall diſtance from the ſides of the Pot, by which means the heat is more effectually confined.

To be able to move about this Pot from place to place, it has two handles which are rivetted to the outſide of its cylindrical caſe; and it is provided with a wooden cover.

I am ſenſible that I often expoſe myſelf to criticiſm by anticipating what would more naturally find its place elſewhere. But what I have here ſaid in regard to this Iron Pot is intended merely as hints to awaken the curioſity and excite the attention of ingenious men,—of ſuch as take pleaſure in exerciſing their ingenuity in contriving and perfecting uſeful inventions, and who delight in contemplating the progreſs of human induſtry.

Model of a perpetual Lime-kiln.

THE particular objects principally had in view in the conſtruction of this Lime-kiln (which ſtands in the court-yard of the Dublin Society) were, *firſt*, to cauſe the Fuel to burn in ſuch a manner as to conſume the ſmoke, which was done by obliging the ſmoke to deſcend and paſs through the Fire, in order that as much heat as poſſible might be generated.—Secondly, to cauſe the flame and hot vapour which riſe from the Fire to come into contact with the lime-ſtone by a very large ſurface, in order to economiſe the heat, and prevent its going off into the atmoſphere; which was done by making the body of the Kiln in the form of a hollow truncated cone, and very high in proportion to its diameter; and by filling it quite up to the top with lime-ſtone, the Fire being made to enter near the bottom of the cone.

Thirdly, to make the proceſs of burning lime *perpetual*, in order to prevent the waſte of heat which unavoidably attends the cooling of the Kiln in emptying and filling it, when, to perform that operation, it is neceſſary to put out the Fire.

And, fourthly, to contrive matters ſo that the lime in which the proceſs of burning is *juſt finiſhed*, and which of courſe is ſtill *intenſely hot*, may, in *cooling*, be made to give off its heat in ſuch a manner as to aſſiſt in heating the freſh quantity of cold lime-ſtone with which the Kiln is repleniſhed as often as a portion of lime is taken out of it.

To effectuate theſe purpoſes, the Fuel is not mixed with the lime-ſtone, but is burned in a cloſed fire-place, which opens into one ſide of the Kiln, ſome diſtance above the bottom of it. For large Lime-kilns on theſe principles there may be ſeveral fire-places, all opening into the ſame cone, and ſituated on different ſides of it; which fire-places may be conſtructed and regulated like the fire-places of the furnaces uſed for burning porcelaine.

At the bottom of the Kiln there is a door, which is occaſionally opened to take out the lime.

When, in conſequence of a portion of lime being drawn out of the Kiln, its contents ſettle down or ſubſide, the empty ſpace in the upper part of the Kiln, which is occaſioned by this ſubtraction of the burned lime, is immediately filled up with freſh lime-ſtone.

As ſoon as a portion of lime is taken away, the door by which it is removed muſt be immediately ſhut, and the joinings well cloſed with moiſt clay, to prevent a draught of cold air through the Kiln. A ſmall opening however muſt be left, for reaſons which I ſhall preſently explain.

As the Fire enters the Kiln at ſome diſtance from the bottom of it, and as the flame *riſes* as ſoon as it comes into this cavity, the lower part of the Kiln (that below the level of the bottom of the fire-place) is occupied by lime already burned; and as this lime is intenſely hot, when, on a portion of lime from below being removed, it deſcends into this part of the Kiln, and as the air in the Kiln, to which it communicates its heat, muſt *riſe upwards* in conſequence of its being heated, and paſs off through the top of the Kiln, this lime in cooling is, by this contrivance, made to aſſiſt in heating the freſh portion of cold lime-ſtone with which the Kiln is charged. To facilitate this communication of heat from the red-hot lime juſt burned, to the lime-ſtone above in the upper part of the Kiln, a gentle draught of air through the Kiln from the bottom to the top of it muſt be eſtabliſhed by leaving an opening in the door below, by which the cold air from without may be ſuffered to enter the Kiln. This opening (which ſhould be furniſhed with ſome kind of a regiſter) muſt be very ſmall, otherwiſe it will occaſion too ſtrong a draught of cold air into the Kiln, and do more harm than good; and it will probably be found to be beſt to cloſe it entirely, after the lime in the lower part of the Kiln has parted with a certain proportion of its heat.

Conceiving the improvement of Lime-kilns to be a matter of very great national importance, eſpecially ſince the uſe of lime as manure has become ſo general, I intend to devote the firſt leiſure time

I can

I can ſpare to a thorough inveſtigation of that ſubject;—in the mean time, I have here thrown out the looſe ideas I have formed reſpecting it, in order that they may be examined, corrected, and improved upon by others who may be engaged in the ſame purſuits.

The model I cauſed to be conſtructed in the court-yard of the Dublin Society, is, I am ſenſible, very imperfect. It was built in a great hurry, being begun and finiſhed the ſame day,—the day but one before I left Ireland;—but I am now engaged in conſtructing a Lime-kiln on the ſame principles, (for the uſe of the farm in the Engliſh Garden at Munich,) which I ſhall take pains to make as perfect as poſſible; and ſhould it be found to anſwer as well as I have reaſon to hope it will, I ſhall not fail to give a particular account of it to the Public, accompanied with drawings, and all the details that ſhall be neceſſary in order to give the moſt ſatisfactory account of the reſult of the Experiment.

Theſe inveſtigations will be the more intereſting, and their reſults more generally uſeful, as the diſcovery of a mine of pit-coal in the neighbourhood of Munich, which is now worked with ſucceſs, has put it in my power to uſe coal as Fuel, as well as wood and turf, in the Experiments I ſhall make in burning lime in this Kiln.

For the information of thoſe who may be diſpoſed to engage in theſe purſuits, I have publiſhed the annexed ſketch of the Lime-kiln in queſtion, which is now actually building (ſee Plate VI.). I thought it right to do this, that we might ſtart fair; and I can aſſure my competitors in this race, that I ſhall feel no ill-will on ſeeing them get before me.

If I do not deceive myſelf, the laudable exertions of others afford me almoſt as much pleaſure as my own purſuits;—at leaſt I am quite certain that when I can flatter myſelf that I have had any,—even the ſmalleſt ſhare,—in *exciting* thoſe exertions, the ſatisfaction I feel in contemplating them is inexpreſſible.

DESCRIP-

Plate 1.

Fig. 1.

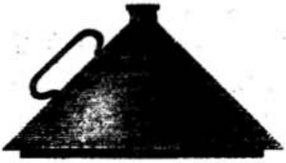


Fig. 2.

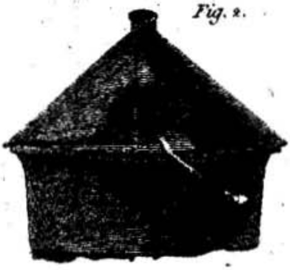


Fig. 3.

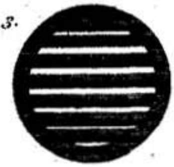
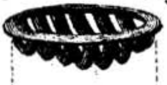


Fig. 4.



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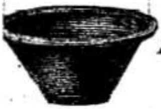


Fig. 6.

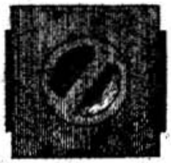


Fig. 7.

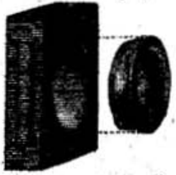
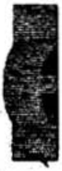


Fig. 8.



Neele sc. Strand.

London Pub.d April 26th 1797, by Cadell & Davies Strand.

DESCRIPTION OF THE PLATES.

PLATE I.

FIG. 1. A view of a double cover for a boiler or ſaucepan. In this deſign the rim is ſeen which enters the boiler, and the tube by which the ſteam goes off is ſeen in part (above),—and is in part indicated by dotted lines. (See page 18.)

Fig. 2 ſhows this cover placed on its boiler. Part of the ſide of the cover is repreſented as wanting, in order that the ſteam tube might be better ſeen. The height of this cover is repreſented as being equal to *one-half* its diameter; but I have found *one third* of its diameter quite ſufficient for its height.

Fig. 3 and Fig. 4 are views of my circular diſhing-grates for cloſed kitchen fire-places. They may be made of any ſize, from 5 inches to 18 inches in diameter, according to the ſize of the boiler. The rules I have in general followed, in determining the ſize proper for the grate for any (circular) boiler, has been to make its diameter equal to half the diameter of the boiler at the brim. (See page 41.)

Fig. 5 is an inverted hollow cone of thin ſheet-iron, which is placed immediately under the grate, its brim being made to receive the circular rim of the grate. When the fire-place is large, this inverted cone may be made of fire-ſtone, or conſtructed of bricks and mortar. For ſmall fire-places it may be made of earthen ware, which is perhaps the very beſt material for it that can be found. (See page 43.)

Fig. 6, Fig. 7, and Fig. 8, are views and ſections of a perforated tile, with its ſtopper, ſuch as are uſed for cloſing the entrance by which the Fuel is introduced into cloſed kitchen fire-places. The diameter of the circular opening, or hole in the tile, may be from 6 to 7 inches. (See page 30.)

PLATE II.

The various Figures, from No. 9 to No. 16 of this Plate, ſhow the conſtruction of an aſh-pit door, with its regiſter. (See page 31.)

Fig. 9 is a front view of the door with its regiſter.—The whole is conſtructed of ſheet-iron, except the four narrow pieces at the four corners, which hold down in its place the circular plate of the regiſter; and the ſmall circular plate (as large as an half-crown) in the centre of the regiſter, which are made of braſs, on account of that metal not being ſo liable to ruſt as iron.

Fig. 10 is a ſide view of the backſide of the door, fixed in its frame, in which the manner of its being ſhut in its frame is ſeen, and the iron ſtraps, *a*, *b*,

Plate 2.

Fig. 9.

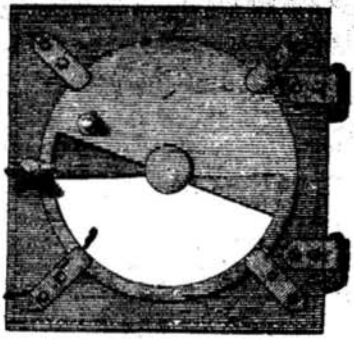


Fig. 10.

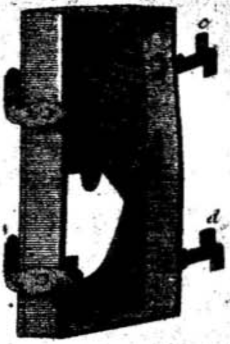


Fig. 11.

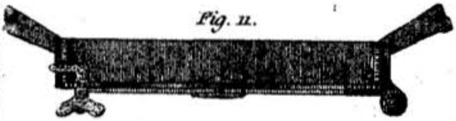


Fig. 12.

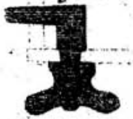


Fig. 13.

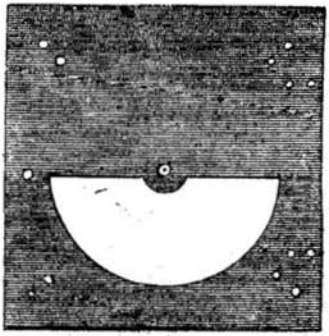


Fig. 14.

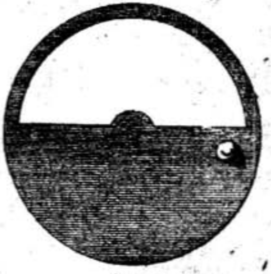


Fig. 15.

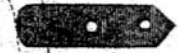
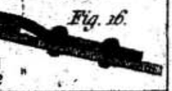
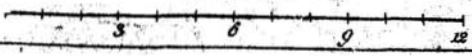


Fig. 16.



Scale of Inches



Neele sc. Strand.

London Pub.d April 20th 1797 by Cadell & Davies Strand.

a, *b*, *c*, *d*, are ſeen, by which the frame is faſtened in the brick-work.

Fig. 11 is an horizontal ſection through the middle of the door and its frame, and through the button which ſerves for ſhutting the door.

Fig. 12 is a ſection of this button, on an enlarged ſcale, ſhowing the manner in which it is conſtructed.

Fig. 13 is the plate of ſheet-iron which forms the front of the door, with the holes in it, by which the other parts of the machinery are fixed to it.

Fig. 14 is the circular plate which forms the regiſter—to this plate is fixed a projecting knob, or button, (repreſented in the Figure,) by which it is turned about.

Fig. 15 and Fig. 16 ſhow, on an enlarged ſcale, one of the four pieces of braſs by which the circular plate of the regiſter is kept down in its place.

In conſtructing theſe regiſter doors, and in general all iron doors for fire-places, great and ſmall, the door ſhould never ſhut in a rabbet, or groove, in the frame, but ſhould merely *ſhut down on the front edge of the frame*, which edge, by grinding it on the flat ſurface of a large flat ſtone, ſhould be made quite level to receive it. If this be done, and if the plate of iron which conſtitutes the door be made quite flat, and if it be properly fixed on its hinges, the door will always ſhut with facility and cloſe the opening with preciſion, notwithſtanding the effects of the expanſion of the metal by heat; but this cannot be the caſe when the doors of fire-places are fitted in grooves and rabbets.

Where the heat is very intenſe, the frame of the door ſhould be made of fire-ſtone; and that part of the door which is expoſed naked to the fire ſhould be covered either with a fit piece of fire-ſtone, faſtened to it with clamps of iron, or a ſufficient number of ſtrong nails, with long necks and flat heads, or of ſtaples, being driven into that ſide of the plate of iron which forms the door which is expoſed, ſhould be covered with a body about two inches thick of ſtrong clay mixed with a due portion of coarſe powder of broken crucibles, which maſs will be held in its place by the heads of the nails and by the projecting ſtaples. This maſs being put on wet, and gently dried, the cracks being carefully filled up as they appear, and the whole well beaten together into a ſolid maſs, will, when properly burned on by the heat of the fire, form a covering for the door which will effectually defend it from all injury from the fire; and the door ſo defended will laſt ten times longer than it would laſt without this defence.

The inſide doors of the two Brew-houſe Fire-places which I have fitted up at Munich are both defended from the heat in this manner; and the contrivance, which has anſwered perfectly all that was expected from it, has not been found to be attended with any inconvenience whatever.

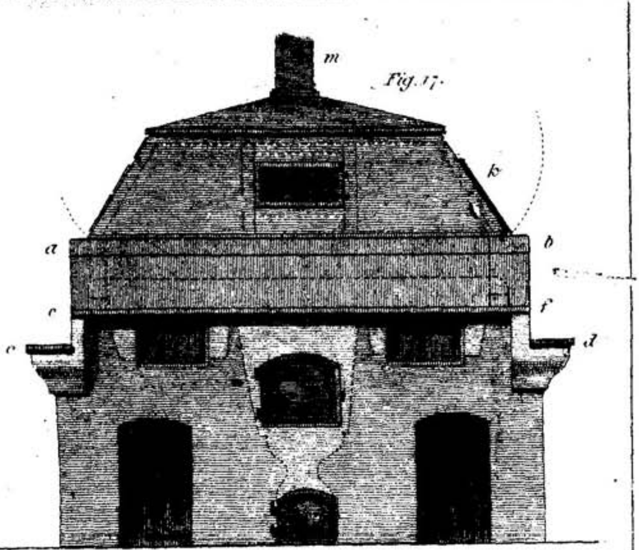


Fig. 17.

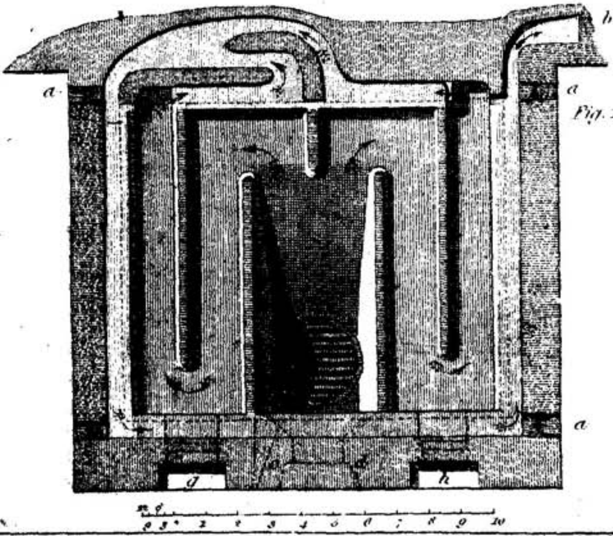


Fig. 18.

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PLATE III.

Fig. 17 is a front view of the new boiler of the brew-houſe called Neuheuſel, or rather of its fire-place and cover (the boiler being concealed in the brick-work). The inſide door of the fire-place is here repreſented ſhut; and, in order that it might appear, the outſide door is taken off its hinges, and is not ſhown. The two vaulted galleries, A, B, in the ſolid maſs of the brick-work, on the right and left of the fire-place, (which were made to ſave bricks,) ſerve for holding fire-wood. The partition walls of the fire-place and the different flues, as alſo a ſection of the boiler, are repreſented by dotted lines. The ſmall circular hole on the left of the fire-place door is the window opening into the fire-place, by which the burning Fuel may be ſeen.

a, *b*, is the wooden curb of the boiler: *c*, *d*, a platform on which the men ſtand when they work in emptying the boiler, &c.: *e*, *f*, is a platform which ſerves as a paſſage from one ſide of the boiler to the other. This platform, which is about 18 inches wide, is 12 inches higher than the other platforms, in order that the openings *g* and *h*, into the flues, may remain free. Theſe openings, which are opened only occaſionally, that is to ſay, when the flues want cleaning, are kept cloſed by double brick-walls. Theſe walls are expreſſed in the following Figure.

Fig. 18. This is a horizontal ſection of the fire-place at a level with the bottom of the boiler,

a, a, a, a, are four openings by which the flues, which, in the firſt arrangement of this fire-place, went round the outſide of the boiler, was occaſionally cleaned: *b* is the canal by which the ſmoke went off into the chimney.

The entrance into the fire-place, and the conical perforation in the wall of the fire-place which ſerves as a window for obſerving the fire, are marked by dotted lines. The poſition of the inſide door of the fire-place is marked by a dotted line, *c, d.* The circular diſhing-grate is ſeen in its place; and the walls of the flues under the boiler are all ſeen. The crooked arrows in the flues ſhow the direction of the flame. (See page 100.)

PLATE IV.

Fig. 19 is a vertical ſection of the boiler repreſented in the foregoing Plate (Fig. 17.). This ſection is taken through the middle of the boiler,—of the fire-place;—and of the cover of the boiler. A is the aſh-pit, with a ſection of its regiſter door. B is the fire-place, and its circular diſhing-grate. C is the entrance by which the Fuel is introduced, with ſections of its two doors. D is a ſpace left void to ſave bricks. E is the boiler, and F its wooden cover. *m* is the ſteam chimney, which is furniſhed with a damper. R, R, is the vertical wall of the houſe againſt which the brick-work in which the boiler is fixed is placed.

a, b, is the curb of timber in which the boiler is ſet.

The

Plate 4.

Fig. 19.

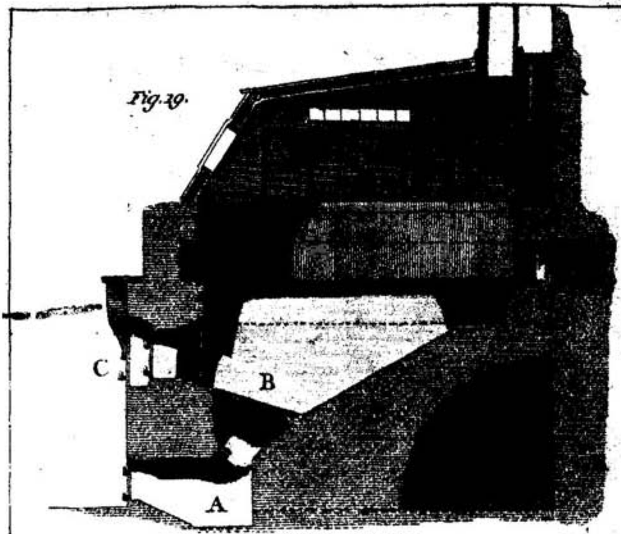

Fig. 20.

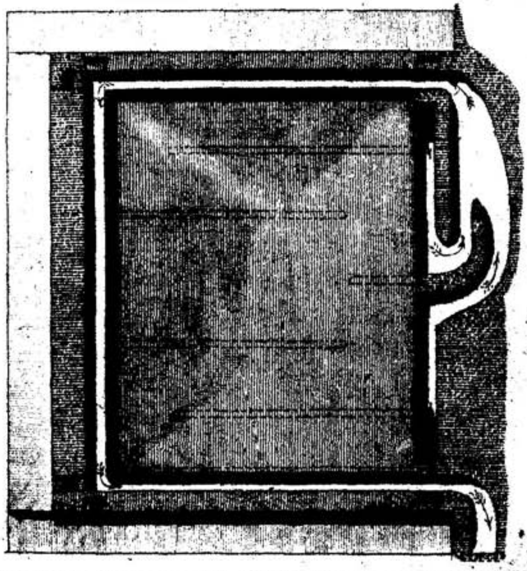

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Fig. 24.

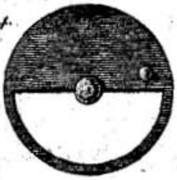


Fig. 23.

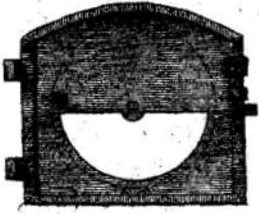


Fig. 22.

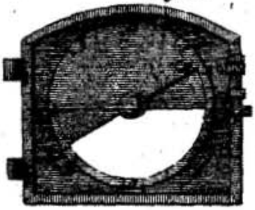
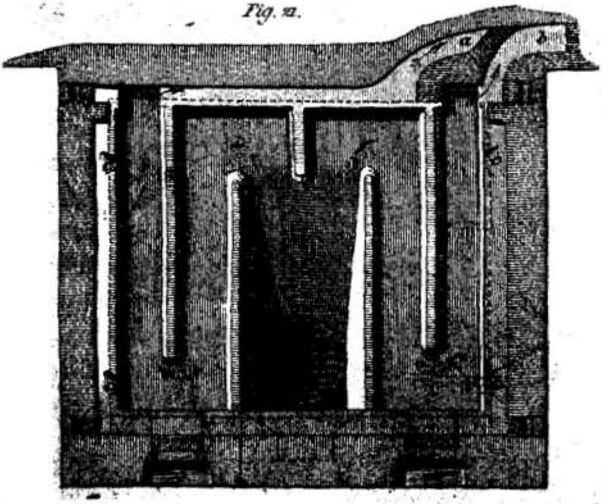


Fig. 21.



Neele sc. Strand.

London Pub.d April 20th 1797 by Cadell & Davies Strand.

The manner in which the cover of the boiler is conſtructed, as well as its form, and the door and windows which belong to it, are all ſeen diſtinctly in this Figure.

Fig. 20 is an horizontal ſection of this fire-place taken on a level with the bottom of the flue which goes round the outſide of the boiler, in which flue, before the fire-place was altered, the flame circulated. The flues under the boiler are, in this Figure, indicated by dotted lines.

PLATE V.

Fig. 21 is an horizontal ſection of the fire-place of the brewhouſe boiler, at a level with the top of the flues under the boiler, *after the flue round the outſide of the boiler had been ſtopped up*, or rather the flame prevented from circulating in it. This Figure ſhows the actual ſtate of the fire-place at the preſent time. (See page 126.)

The crooked arrows ſhow the direction of the flame in the flues—*a*, *b*, are the two canals (each of which is furniſhed with a damper) by which the ſmoke goes off into the chimney;—and *c*, *c*, *c*, *c*, *c*, *c*, are ſix ſmall openings communicating with the flues, by which the flame and hot vapour can paſs up into the cavity on the outſide of the boiler which formerly ſerved as a flue.

Fig. 22 is a front view of the aſh-pit door of this brewhouſe fire-place, with its regiſter. This door is cloſed by means of a latch of a particular conſtruction, which is ſhown in the Figure.

Fig. 23 is the door without its regiſter;—and

Fig. 24 the circular plate of the regiſter repreſented alone.

This aſh-pit door ſhuts againſt the front edge of its frame, and not into it; the reaſons for preferring this method of fitting the door to its frame have already been explained. (See deſcriptions of the Plate II.)

PLATE VI.

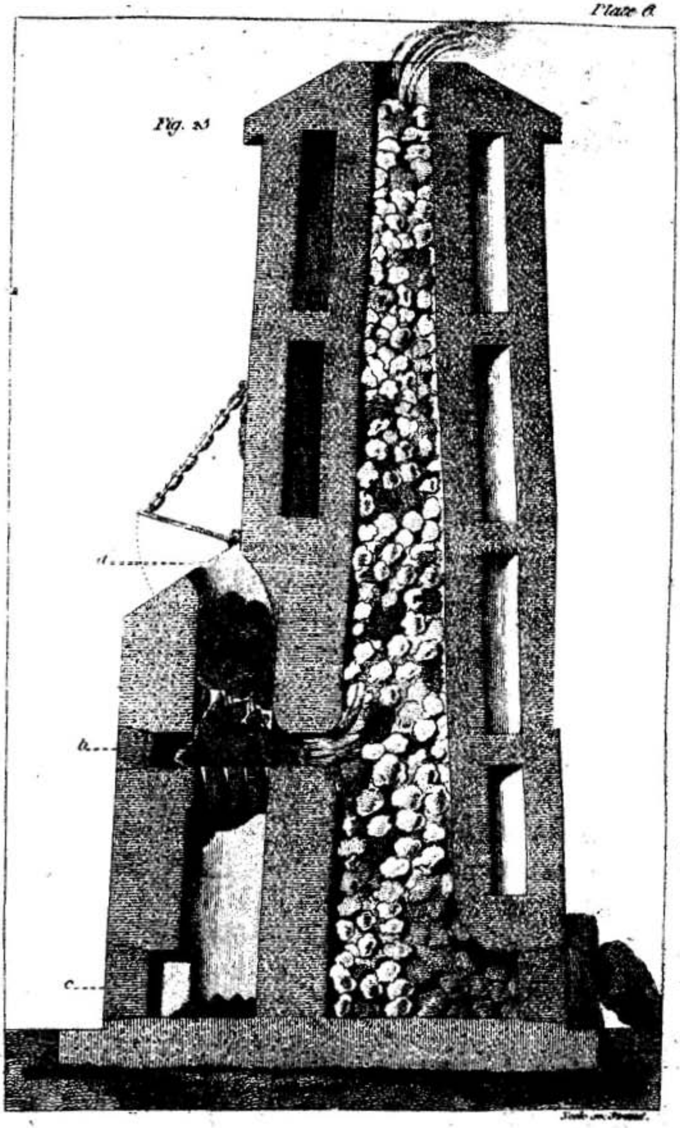
Fig. 25 is a ſection of a ſmall lime-kiln, built, or rather now building, at Munich, for the purpoſe of making experiments. The height of the kiln is 15 feet;—its internal diameter below, 2 feet,—and above, 9 inches. In order more effectually to confine the heat, its walls, which are of bricks and very thin, are double, and the cavity between them is filled with dry wood aſhes. To give greater ſtrength to the fabric, theſe two walls are connected in different places by horizontal layers of bricks which unite them firmly.

a is the opening by which the fuel is put into the fire-place. Through this opening the air *deſcends* which feeds the fire. The fire-place is repreſented nearly full of coals, and the flame paſſing off laterally into the cavity of the kiln, by an opening made for that purpoſe at the bottom of the fire-place.

The opening above, by which the fuel is introduced into the fire-place, is covered by a plate of iron,

Plate 6.

Fig. 23



Cook sc. Strand.

London Pub.d April 15th 1797 by Cadell & Davies Strand

iron, moveable on hinges; which plate, by being lifted up more or leſs by means of a chain, ſerves as a regiſter for regulating the fire.

A ſection of this plate, and of the chain by which it is ſupported, are ſhown in the Figure.

b is an opening in the front-wall of the fire-place, which ſerves occaſionally for cleaning out the fire-place, and the opening by which the flame paſſes from the fire-place into the kiln. This opening, which muſt never be quite cloſed, ſerves likewiſe for admitting a ſmall quantity of air to paſs horizontally into the fire-place. A ſmall proportion of air admitted in this manner has been found to be uſeful and even neceſſary in fire-places in which, in order to conſume the ſmoke, the flame is made to deſcend. Several ſmall holes for this purpoſe, fitted with conical ſtoppers, may be made in different parts of the front wall of the fire-place.

The bottom of the fire-place is a grate conſtructed of bricks placed edgewiſe, and under this grate there is an aſh-pit; but as no air muſt be permitted to paſs up through this grate into the fire-place, the aſh-pit door, *c*, is kept conſtantly cloſed, being only opened occaſionally to remove the aſhes.

d is the opening by which the lime is taken out of the kiln; which opening muſt be kept well cloſed, in order to prevent a draught of cold air through the kiln.

As only as much lime muſt be removed at once as is contained in that part of the kiln which lies below the level of the bottom of the fire-place, to be able to aſcertain when the proper quantity is taken away, the lime, as it comes out of the kiln, may be directed into a pit ſunk in the ground in front of the opening by which the lime is removed, this pit being made of proper ſize to ſerve as a meaſure.

While the lime is removing from the bottom of the kiln, freſh lime-ſtone ſhould be put into it above; and, during this operation, the fire may be damped by cloſing the top of the fire-place with its iron-plate.

Should it be found neceſſary, the fire, and the diſtribution of the heat, may, in burning the lime, be farther regulated by cloſing more or leſs the opening at the top of the lime-kiln with a flat piece of fire-ſtone, or a plate of caſt iron.

The double walls of the kiln, and the void ſpace between them, as alſo the horizontal layers of bricks by which they are united, are clearly and diſtinctly expreſſed in the Figure. The kiln is repreſented as being nearly filled with ſmall round ſtones, ſuch as are uſed at Munich in burning lime. Theſe ſtones are brought down from the calcareous mountains on our frontiers, by the river (the Iſar), and are rounded by rubbing againſt each other as they are rolled along by the impetuoſity of the torrent.

END OF THE SIXTH ESSAY.

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OF

PART I. of ESSAY VII.

PART I.

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ESSAY VII.

OF

THE PROPAGATION OF HEAT IN FLUIDS.

IN TWO PARTS.

The bulb of the thermometer being ſurrounded by water, or by any other liquid, or mixture, the conducting power of which was to be aſcertained, a cylinder of cork ſomething leſs in diameter than the braſs cylinder,—about half an inch long, with a hole in its centre, in which the tube of the thermometer paſſed freely,—was thruſt down into the braſs cylinder, but not quite ſo low as to touch the ſurface of the water, or other ſubſtance it contained. This cylinder, or diſk, was ſupported in its proper place by three projecting braſs points or pins, which were fixed with ſolder to the outſide of the metallic neck of the bulb of the thermometer.

As ſoon as this diſk of cork is put into its place, the upper part of the hollow braſs cylindrical tube is filled with eider-down, and it is cloſed above with its cork ſtopper, the tube of the thermometer, which paſſes through a fit hole in the middle of this ſtopper, projecting upwards. As the whole ſcale of the thermometer, from the point of freezing to that of boiling water, is above the upper ſurface of this ſtopper, all the changes of heat to which the inſtrument is expoſed, can be obſerved at all times without deranging any part of the apparatus.

The thermometer is divided according to the ſcale of Fahrenheit, and its diviſions are made to correſpond with a very accurate mercurial thermometer made by TROUGHTON.

The experiments with this inſtrument, which, for the ſake of diſtinction, I ſhall call my *cylindrical paſſage*

paſſage thermometer, were made in the following manner: The thermometer being fixed in its cylindrical braſs tube, in the manner above deſcribed, and ſurrounded by the ſubſtance the conducting power of which was to be aſcertained, the inſtrument was placed in thawing ice, where it was ſuffered to remain till the thermometer fell to 32°. It was then taken out of the melting ice, and immediately plunged into a large veſſel of boiling water, and the conducting power of the ſubſtance which was the ſubject of the experiment was eſtimated by the time employed by the Heat in paſſing through it into the thermometer; the time being carefully noted when the liquid in the thermometer arrived at the 40th degree of its ſcale; and alſo when it came to every 20th degree above it.

As the ſlower Heat moves, or is tranſported, in any medium, the longer muſt of courſe be the time required for any given quantity of it to paſs through it; and as the thermometer ſhows the changes which take place in the temperature of the body which is heated or cooled,—(namely, the liquid with which the thermometer is filled,)—in conſequence of the paſſage of the Heat through the medium by which the thermometer is ſurrounded, the conducting power of that medium is ſhown by the quickneſs of the aſcent or deſcent of the thermometer, when, having been previouſly brought to a certain temperature, the inſtrument is ſuddenly removed and plunged into another medium at any other conſtant given temperature.

Having ſtill freſh in my memory the accidents I had ſo often met with in eating hot Apple-pies, I was very impatient, when I had completed this inſtrument, to ſee if Apples, which, as I well knew, are compoſed almoſt entirely of water, really poſſeſs a greater power of retaining Heat than that liquid when it is pure, or unmixed with other bodies. But before I made the Experiment, in order that its reſult might be the more ſatisfactory, I determined, in the following manner, how much water there really is in Apples, and what proportion their fibrous parts bear to their whole volume.

960 Grains of ſtewed Apples (the Apples having been carefully pared and freed from their ſtems and ſeeds before they were ſtewed) were well waſhed in a large quantity of cold ſpring water, and the fibrous parts of the Apples being ſuffered to ſubſide to the bottom of the veſſel, the clear part of the liquor was poured off, and the fibrous remainder being thoroughly dried was carefully weighed, and was found to weigh juſt 25 grains.

This fibrous remainder of the 960 grains of ſtewed Apples being again waſhed in a freſh quantity of cold ſpring water, and afterwards very thoroughly dried, by being expoſed ſeveral days on a china plate placed on the top of a German ſtove, which was kept conſtantly hot, was again weighed, and was found to weigh no more than $18\frac{9}{10}$ grains.

From this Experiment it appears that the fibrous parts of ſtewed Apples amount to leſs than $\frac{1}{50}$ part of the whole maſs; and there is abundant reaſon to conclude that the remainder, amounting to $\frac{49}{50}$ of the whole, is little elſe than pure water.

Having ſurrounded the bulb of my cylindrical paſſage thermometer with a quantity of theſe ſtewed Apples, (the conſiſtence of the maſs being ſuch that it ſhewed no ſigns of fluidity,) the inſtrument was placed in pounded ice, which was melting, and when the thermometer indicated that the whole was cooled down to the temperature of 32°, the inſtrument was taken out of the melting ice, and plunged into a large veſſel of boiling water, and the water being kept boiling with the utmoſt violence during the whole time the Experiment laſted, the times taken up in heating the thermometer from 20 to 20 degrees were obſerved and noted down in a table, which had been previouſly prepared for that purpoſe.

This Experiment having been repeated twice, and varied as often by firſt heating the inſtrument to the temperature of boiling water, and then plunging it into melting ice, and obſerving the time taken up in the paſſage of the heat *out* of the thermometer; I removed the ſtewed Apples which ſurrounded the bulb of the thermometer, and filling the ſpace they had occupied with *pure water*, I now repeated the Experiments again with that liquid. The following Tables ſhow the reſults of theſe Experiments.

	Time the Heat was paſſing INTO the Thermometer,			
	Through ſtewed Apples.		Through Water.	
	Exp. No. 1.	Exp. No. 3.	Exp. No. 5.	Exp. No. 7.
	Seconds.	Seconds.	Seconds.	Seconds.
In heating the Thermometer from the temperature of 32° to that of - 40°	95	89	45	45
from 40° to 60°	75	67	36	35
60° to 80°	61	56	34	31
100°	65	60	30	30
120°	73	66	37	36
140°	90	82	44	44
160°	121	113	63	60
180°	188	170	93	90
200°	360	364	226	215
Total times in heating from 32° to 200°	1128	1057	608	586
Times employed in heating the inſtrument 80 degrees, viz. from 80° to 160°	349″	321″	174″	170″
Mean times in heating it from 80° to 160°	In ſtewed Apples 335″		In Water 172″	

The reſults of theſe Experiments ſhow that Heat paſſes with much greater difficulty, or much ſlower, in *ſtewed Apples* than in *pure Water*; and as ſtewed Apples are little elſe than water mixed with a very ſmall proportion of fibrous and mucilaginous matter, this ſhows that the conducting power of water with regard to Heat *may be impaired.*

The reſults of the following Experiments will ſerve to confirm this concluſion.

	Time the Heat was paſſing OUT OF the Thermometer,			
	Through ſtewed Apples.		Through Water.	
	Exp. No. 2.	Exp. No. 4.	Exp. No. 6.	Exp. No. 8.
	Seconds.	Seconds.	Seconds.	Seconds.
In cooling the Thermometer from the temperature of 200° to that of - 180°	80	74	46	37
from 180° to 160°	75	72	42	37
160° to 140°	84	83	43	43
120°	107	101	54	51
100°	141	136	73	73
80°	198	190	112	105
60°	321	307	200	204
40°	775	733	483	461
Total time in cooling from 200° to 40°	1781	1696	1053	1011
Times employed in cooling the inſtrument 80 degrees, viz. from 160° to 80°	530″	510″	282″	272″
Mean time in cooling it from 160° to 80°	In ſtewed Apples 520″		In Water 277″	

As the heating or cooling of the inſtrument goes on very ſlowly when it approaches to the temperature of the medium in which it is placed, while, on the other hand, this proceſs is very rapid when, the temperature of the inſtrument being very different from that of the medium, it is firſt plunged into it, both theſe circumſtances conſpire to render the obſervations made at the extremities of the ſcale of the thermometer more ſubject to error, and conſequently leſs ſatisfactory than thoſe made nearer the middle of it: In order that the general concluſions drawn from the reſult of the Experiments might not be vitiated by the effects produced by theſe unavoidable inaccuracies, inſtead of eſtimating the celerity of the paſſage of the Heat by the times elapſed in heating and cooling the thermometer *through the whole length of its ſcale*, or between the point of freezing to that of boiling water, I have taken the times elapſed in heating and cooling it 80 *degrees in the middle of the ſcale*, viz. between 80° and 160°, as the meaſure of the conducting powers of the ſubſtances through which the Heat was made to paſs.

I have, however, noted the times which elapſed in heating and cooling the inſtrument through a much larger interval, namely, through an interval of 168 degrees in *heating*,—or from 32° to 200°,—and in *cooling* through 160 degrees, or from 200° to 40°.

In reſpect to the *cooling* of the inſtrument, it is neceſſary that I ſhould inform my reader, that though I have not in the Tables of the Experiments mentioned any higher temperature than that of 200°, yet the inſtrument was always heated to the point of boiling water, which, under the preſſure of the atmoſphere at Munich, where the Experiments were made, was commonly about 209½ deg. of Fahrenheit's ſcale. The inſtrument being kept in boiling water till its thermometer appeared to be quite ſtationary, was then taken out of the water, and inſtantly plunged into melting ice, and the time was obſerved and carefully noted down when the liquid in its thermometer paſſed the diviſion of its ſcale which indicated 200°, as alſo when it arrived at the other diviſions indicated in the Tables.

With regard to the four laſt mentioned Experiments, (No. 2, 4, 6, and 8,) it will be found on examination that their reſults correſpond very exactly with thoſe before deſcribed; and they certainly prove in a very deciſive manner this important fact:—*that a ſmall proportion of certain ſubſtances, on being mixed with water, tend very powerfully to impair the conducting power of that Fluid in regard to Heat.*

In the Experiments No. 1 and No. 2, which were both made on the ſame day, and in the order in which they are numbered, the Heat was conſiderably more obſtructed in its paſſage through the maſs of ſtewed Apples which ſurrounded the thermometer than in the Experiments No. 3 and No. 4, which were made on the following day. It is probable that this was occaſioned by ſome change in the conſiſtency of this ſoft maſs of the ſtewed Apples which had taken place while the inſtrument was left to repoſe in the interval between the Experiments: but, inſtead of ſtopping to ſhow how this might be explained, I ſhall proceed to give an account of ſome Experiments from the reſults of which we ſhall derive information that will be much more ſatisfactory than any ſpeculations I could offer on that ſubject.

Suppoſing Heat to be propagated in water in the ſame manner as it is propagated in air and other elaſtic Fluids, namely, that it is *tranſported* by its particles, theſe particles being put in motion by the change which is produced in their ſpecific gravity, by the change of temperature, and that there is no communication whatever, or *interchange of their Heat*, among the particles of *the ſame Fluid*,—in that caſe, it is evident that the Propagation of Heat in a Fluid may be obſtructed in two ways, namely, by diminiſhing its *Fluidity*, (which may be done by diſſolving in it any mucilaginous ſubſtance,) or, more ſimply, by merely embarraſſing and obſtructing the motion of its particles in the operation of tranſporting the Heat, which may be effected by mixing with the Fluid any ſolid ſubſtance,—(it muſt be a non-conductor of Heat however,)—in ſmall maſſes, or which has a very large ſurface in proportion to its ſolidity.

In the foregoing Experiments with *ſtewed Apples*, the paſſage of the Heat in the water, (which conſtituted by far the greateſt part of the maſs,) was doubtleſs obſtructed in both theſe ways. The mucilaginous parts of the Apples diminiſhed very much the fluidity of the water, at the ſame time that the fibrous parts ſerved to embarraſs its internal motions.

In order to diſcover the *comparative effects* of theſe two cauſes, it was neceſſary to ſeparate them; or to contrive Experiments, in which only one of them ſhould be permitted to act at the ſame time. This I endeavonred to do in the following manner.

To aſcertain the effects produced by diminiſhing the *fluidity* of water, I mixed with it a ſmall quantity of *ſtarch*, namely, 192 grains in weight to 2276 grains of water;—and to determine the effects produced by merely *embarraſſing* the water in its motions, I mixed with it an equal proportion (by weight) of EIDER-DOWN. The ſtarch was boiled with the water with which it was mixed; as was alſo the eider-down. This laſt mentioned ſubſtance was boiled in the water in order to free it from air, which, as is well known, adheres to it with great obſtinacy.

In order that theſe Experiments might, with greater facility, be compared with thoſe which were made with *ſtewed Apples*, and with *pure Water*, I ſhall place their reſults all together, in the following Tables.

	Time the Heat was in paſſing INTO the Thermometer,			
	Through a Mixture of 2276 grains of Water, and 192 grs. of STARCH.	Through a Mixture of 2276 grains of Water, and 192 grs. of EIDER-DOWN.	Through STEWED APPLES.	Through pure WATER.
	Experiment No. 9.	Experiment No. 11.	Mean of two Exp. N° 1 & N° 3.	Mean of two Exp. N° 5 & N° 7.
	Seconds.	Seconds.	Seconds.	Seconds.
In heating the Thermometer from 32° to 40°	101	83	92	45
from 40° to 60°	72	55	71	35½
60° to 80°	64	49	58½	32½
100°	63	52	62½	30
120°	74	57	69½	36½
140°	89	67	86	44
160°	115	93	117	61½
180°	178	133	179	91½
200°	453	360	362	220½
Total times in heating the inſtrum^{t} from 32° to 200°	1109	949	1096½	597
Times employed in heating the Thermometer 80 degrees, viz. from 80° to 160°	341″	269″	335″	172″

	Timet he Heat was in paſſing OUT OF the Thermometer,			
	Through a Mixture of 2276 grains of Water, & 192grs.of STARCH.	Through a Mixture of 2276 grains of Water, and 192 grs. of EIDER-DOWN.	Through STEWED APPLES.	Through pure WATER.
	Exp. No. 10.	Experiment No. 12.	Mean of two Exp. N° 2 & N° 4.	Mean of two Exp. N°6 & N°8.
	Seconds.	Seconds.	Seconds.	Seconds.
In cooling the Thermometer from 200° to 188°	69	68	77	41½
from 180 to 160°	66	61	73½	39½
160° to 140°	74	72	83½	43
120°	92	91	104	52½
100°	119	120	138½	73
80°	173	177	194	108½
60°	283	279	314	202
40°	672	673	754	472
Total times in cooling from 200° to 40°	1548	1541	1749½	1032
Times employed in cooling the inſtrument 80 degrees, viz. from 160° to 80°	468″	460″	520″	277″

As the reſults of theſe Experiments prove, in the moſt deciſive manner, that the Propagation of Heat in water is retarded, not only by thoſe things which diminiſh its fluidity, but alſo by thoſe which, by mechanical means, and without forming any combination with it whatever, merely obſtruct its internal motions; it appears to me, that this proves, almoſt to a demon-